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Virginia Institute of Marine Science Twenty-Seventh Annual Report

Virginia Institute of Marine Science

TWENTY-SEVENTH

ANNUAL REPORT

PERIOD ENDING 30 JUNE, 1968

GLOUCESTER POINT, VIRGINIA
23062

VIMS Annual Report

July 1969

Virginia Institute of Marine Science

Gloucester Point, Virginia 23062

Twenty-Seventh Annual Report

for the

Period Ending 30 June 1968

Commonwealth of Virginia

Richmond

1969

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VIRGINIA INSTITUTE OF MARINE SCIENCE

Gloucester Point, Virginia

Honorable Mills E. Godwin, Jr.
Governor of Virginia
Richmond, Virginia

Dear Governor Godwin:

I respectfully submit to you the Twenty-Seventh Annual Report of the Virginia Institute of Marine Science covering the period ending 30 June 1968.

Due to considerable growth in research activities and personnel during the previous several years, the administrative load of VIMS became such that it was necessary to reorganize the various departments into divisions and spread this load. Two Assistant Directors were appointed to administer the research divisions that resulted. Additional improvements are in prospect.

Virginia's oceanographic research and education program at VIMS showed marked development and progress during this period. Due to these increased capabilities, our scientists continued to improve their surveillance of marine resource uses and use problems, and this has considerably enhanced our posture as a marine resource-use advisory agency.

Institute scientists published forty-two research papers during the period. These represent only a fraction of the work conducted. Quantities of data and advice were issued in response to inquiries from various marine resource users and managers representing industrial, local, state and federal organizations and individuals. We have worked closely with the several state and interstate marine resource management agencies.

The James River Hydraulic Model continued in use as a problem-solving instrument for Institute scientists and for other organizations having research or resource-use interests in the James.

The programs of education at the undergraduate and graduate levels, carried out by VIMS through affiliation with the College of William and Mary and the University of Virginia, graduated the largest group of young marine scientists during a single year. Ten received M.A. degrees and the first Ph.D. degree to be conferred under these programs was earned by Dr. Paul E. Hargraves.

The Institute has worked closely with the Virginia Water Control Board and with federal agencies and various political subdivisions in the area of pollution abatement and control. These activities are increasing rapidly in

the wake of strong interest at local, state and national levels. The close association and cooperation that has evolved between these organizations and VIMS is increasingly fruitful.

We have also improved our services to the seafood industry through increased contacts with individuals and with associations of the industry. Our services to the public fishing and recreational interests and to developers of marinas and harbors in the interest of public users have multiplied as a result of closer working arrangements with the Marine Resource Commission.

Combined efforts with the Virginia Department of Health, Virginia Water Resources Commission, the U.S. Army Corps of Engineers, the U.S. Navy, the U.S. Army, the U.S. Coast and Geodetic Survey, the U.S. Environmental Science Services Administration, the U.S. Federal Water Pollution Control Administration, the National Aeronautics and Space Administration, the U.S. Bureau of Commercial Fisheries and the U.S. Bureau of Sport Fisheries and Wildlife are underway to improve our services to all segments of the marine-resource based economy of the Commonwealth.

The Board of Administration, the executive officers and the staff of the Institute hope to be able to improve the Institute's contributions to the state and Nation markedly in the next decade and beyond.

With thanks for your continued interest and support of Virginia's marine research, service and training program, I am

Respectfully yours,
William J. Hargis, Jr.
Director

1967-1968

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The VIMS Administrative Staff. (Left to right) Dr. Edwin B. Joseph, Assistant Director, Dr. John L. Wood, Associate Director, Dr. William J. Hargis, Jr., Director, and Dr. Morris L. Brehmer, Assistant Director.

ORGANIZATIONAL STRUCTURE

OFFICE OF THE DIRECTOR

Director: William J. Hargis, Jr.
Associate Director: John L. Wood

Department of Information and Education

Department of Data Processing and Statistical Services

Library

Wachapreague Laboratory

DIVISION OF ADMINISTRATION

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Office of the Assistant Administrative Director

Department of Maintenance of Buildings and Grounds

Department of Vessel Operations

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Department of Ecology-Pollution

Department of Applied Marine Biology

DIVISION OF BIOLOGICAL AND PHYSICAL OCEANOGRAPHY

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Department of Ichthyology – Davis

Department of Crustaceology – WAVE

Department of Microbiology-Pathology – Perkins

Department of Environmental Physiology –

Department of Physical, Chemical and Geological Oceanography – Harrison

RESEARCH PROGRAMS AT VIMS

MOLLUSK INVESTIGATIONS

Controlling MSX

Research aimed at rearing disease-resistant oysters for rehabilitating abandoned oyster grounds in lower Chesapeake Bay has produced useful results more rapidly than had been expected. Both native and selected laboratory-bred progeny reared from spatfall, or shortly after setting, to seed size in MSX-infested waters and transplanted to other MSX-infested areas have been raised to market size without sustaining intolerable losses.

In seed exposed early to this disease and later planted in MSX-infested areas the annual loss attributable to MSX was usually less than 20%, while the loss sustained by seed not hitherto exposed to this disease organism was 50%-70% in each of the first two years. It appears that if oysters come in contact with MSX at a very early age they acquire some resistance. There is also evidence that genetic resistance can be obtained through selective breeding.

Monitoring public oyster beds

The monitoring program on public beds for determining the success of setting, the degree of fouling, the density of population and other observations designed to provide advice to the industry and management has been continued. Weekly spatfall is monitored at representative stations in the York, James, Rappahannock, Nansemond, Wicomico and Piankatank rivers. During 1968, setting began in the James, York, Piankatank and Wicomico rivers the third week in June and was much heavier than for the same period in 1967.

Oyster culture practices

A list has been prepared of all individuals or companies holding over 20 acres of oyster grounds together with the location of each leased plat. VIMS personnel plan to interview growers in respect to production and other aspects of oyster culture. Useful information will be made available to planters interested in receiving it.

Estimation of hard and soft clam populations

In December 1967, a program was initiated to study hard and soft clam populations in the lower part of Chesapeake Bay. Preliminary study

Oysters held in trays suspended from the VIMS pier are monitored periodically for diseases, fouling organisms, predators, and for growth.

suggests that commercial quantities of soft clams exist in the Rappahannock River and in tributaries of the Virginia side of the Potomac.

The hydraulic escalator, mounted on a 40-foot boat for locating beds of both hard and soft clams and determining their potential productivity, became operational during May 1968. It is more efficient than conventional methods for harvesting hard and soft clams. In a series of tests conducted in Hampton Roads, over 40 bushels of hard clams were landed in 4½ hours. Sediments from dredging operations had little adverse effect upon areas 150 feet beyond the site of operation.

A survey of juvenile soft and hard clams has been made in the lower York River. An abundance of soft clams was present during winter and spring, but heavy mortalities during the summer left few survivors by fall. Juvenile hard clams were scarce in the York River indicating a low recruitment rate for 1967.

Aquaculture methods for clams and scallops

Good results have been obtained in culturing clams and scallops at VIMS Wachapreague Laboratory. An artificial food for clams has been tested with fair results, and some promising methods for protecting bivalves from predation have been devised and are being tested.

RESEARCH ON FINFISH

Research designed to provide information useful for developing and regulating the Commonwealth's finfisheries is described below.

Characterization of coastal and estuarine fish nursery grounds as natural communities

The principal part of this research was the examination of two inshore environments which, though diverse in character, were both believed to serve as nursery grounds for the juvenile stages of a variety of coastal and estuarine fishes. The low-salinity nursery as typified by the upper York and lower Pamunkey rivers is, without question, of major importance. The high-salinity nurseries along the Eastern Shore of Virginia failed to live up to scientists' expectations as nursery grounds, although the several years during which the Eastern Shore studies were conducted may not have been typical.

The differences observed in terms of utilization of the two areas as nursery grounds led to certain basic conclusions about nursery grounds in general. Each successful nursery ground must meet at least three broad criteria: the area must be physiologically suitable; it must provide an abundant and acceptable food supply, and it must provide a degree of protection from predation. The two areas seem to differ principally in the degree of protection from predation that is provided. Both areas are predominantly detritus-based communities and it appears that extensive marshlands pro-

vide the detritus. Still, the study shows clearly that not all marsh areas are equally important as nursery ground, and it provides at least some means of evaluation.

Investigation of potential for expansion of the industrial fishery of the mid-Atlantic bight

During the 1967-68 fiscal year the exploratory phases of this project were completed and considerable progress was made on the analyses of data collected over a two-year period.

The first of the two years was devoted principally to an investigation of seasonal distribution of benthic fishes in the Chesapeake Bight. In the second year of activity the emphasis shifted to obtaining preliminary estimates of abundance. These estimates are an expression of the numbers of pounds of fishes now unused that would be available to an industrial fishery in each season.

The winter season proved to have the greatest potential for fish for industrial purposes. The average catch rate at 76 stations was 2300 pounds per hour. In spring the catch rate declined to 475 pounds per hour averaged over the entire shelf. During the summer, the catch rate declined further to 380 pounds per hour. By autumn, spiny dogfish, which made up nearly half of the total of the previous winter catch, had started their southward migration again and comprised a significant portion of the catch. The estimates that have been derived to this point will be further refined. The revised estimates can be expected to differ considerably from those presented here.

Estimation of parameters of striped bass populations and description of the fishery of lower Chesapeake Bay

Near the end of the fiscal year preceding that covered by this report, a contract was developed between the Institute and the Bureau of Sport Fisheries and Wildlife for the conduct of a three-year study on population dynamics of striped bass stocks in lower Chesapeake Bay. This project was staffed and in operation at the beginning of the 1967-68 fiscal year.

Considerable progress was made this year in describing the age composition of striped bass stocks in the James, the York and Rappahannock rivers. This kind of information provided the baseline for work in population dynamics. Since a variety of commercial fishing gear, as well as hook and line employed by sportfishermen is used in striped bass fishing, it was necessary to determine the age composition of the catch of each segment of the fishery. This has been accomplished for a period of one year but is being repeated.

The estimates of mortality and survival will be based on the results of a tag and recapture program. Over 3000 fish were tagged during this report period. The analyses are incomplete.

During the fiscal year, an attempt was made to measure year-class strength in each river system as an aid to interpretation of other data. This

Scientists (above) measure, weigh and take scales from striped bass for studies of population dynamics; (below) a two-ton catch of spiny dogfish on the chartered commercial trawler SEA BREEZE taken by VIMS ichthyologists investigating the fisheries potential of the continental shelf.

phase of the work has indicated very clearly that success of reproduction can vary significantly from one major river to the next in the same season.

Biology and utilization of anadromous alosids

A continuing investigation of the biology and utilization of shad, hickory shad and the two species of river herring occurring in local waters enabled scientists to delimit geographically their spawning grounds and nurseries in the Rappahannock River and its tributaries and in the Virginia portion of the Potomac River and its tributaries.

INVESTIGATIONS OF CRUSTACEA

Forecasts of abundance of blue crabs

Commercial landings of blue crabs in the Chesapeake were substantially smaller from July 1967 through June 1968 than those of the previous 12 months. This decline had been predicted in the spring of 1967.

The magnitude of the decrease was more effectively shown when landings were recomputed for a crab biological year, extending from September, when one-year-old crabs become sexually mature, fully grown and enter the hard crab fishery, until the following August, by which time most have disappeared. Thus, the hatch of 1966 contributed 55 million pounds of crabs from September 1967 through August 1968, which is only 57% of the catch of 97 million pounds produced by the 1965 hatch.

Regular monthly trawl surveys in the York, James and Rappahannock rivers in the fall of 1967 and the first half of 1968 revealed fewer young crabs hatched in 1967 than in any of the last 10 years. Consequently, it was predicted that the commercial catch from September 1968 through August 1969 would be at new low levels.

Management of the blue crab fishery

Preliminary steps have been made toward a long-term, joint Maryland-Virginia biological study which may lead to more effective management of the Chesapeake Bay crab stocks.

VIMS scientists believe that two factors have favored Virginia's larger catch, compared with Maryland's: (1) There has been a greater fishing effort in Virginia, and (2) the center of the blue crab population has been located in the Virginia portion of the Bay; i.e., under the present and recent natural environmental conditions, such as salinity and temperature, more crabs will usually be found in Virginia waters than in Maryland.

Further, VIMS scientists believe that no increase in the crab population can be achieved by protection of sponge crabs (egg-bearing females) beyond that already given. Some protection has been given in Virginia every year since 1916.

VIMS will not recommend any changes in Virginia's program and policy of management of blue crab stocks until such time in the future that the results of the bi-state study demonstrate the need for change.

Pasteurization of crab meat

There are standard procedures for preparing fresh-cooked crab meat ensuring that a high-quality product can be offered the consumer. Recent advances in methods for pasteurizing crab meat have provided for another high-quality product with a long shelf life when kept under refrigeration.

Limited experience with pasteurization in Virginia and North Carolina, when compared with that in Maryland, prompted the formation of a Tri-State Seafood Committee. Representatives of industry, health departments, research and management agencies in the three states met and proposed uniform processing procedures and regulations.

Parasitism of mud crabs

The sacculinid parasite *Loxothylacus panopaei* was first reported in Chesapeake Bay in the fall of 1964. It probably was introduced in shipments of live oysters imported from the Gulf of Mexico.

The sacculinid, a fleshy barnacle, has been found on two species of mud crabs, *Eurypanopeus depressus* and *Rhithropanopeus harrisii*. Three other species of mud crabs in the Chesapeake area and the blue crab appear to be immune. Sacculinid-infected crabs were found in all the tributaries of the Chesapeake as far north as Deal Island, Maryland in Tangier Sound, but none were found on the ocean side of the Eastern Shore of Virginia or Maryland.

ECOLOGY-POLLUTION STUDIES

Study of environmental factors in three rivers

A biological and chemical study of the James, York and Rappahannock estuaries was initiated in July 1967 under a matching fund contract with the Office of Water Resources Research, U.S. Department of the Interior.

This study was designed to define the environmental factors which determine the major ecological differences which exist between the three systems. Data which were secured and analyzed at VIMS suggested that these differences may have been due to nutrient levels as influenced by enrichment from the fresh water zone and by the turn-over rates within the systems. Nutrients in marsh areas are derived from the land through runoff of rain water and high water flushing. Marsh vegetation stores these nutrients for a time; then, when the plants die and disintegrate, the nutrients are flushed into the river systems.

The four forms of phosphorus and five forms of nitrogen in the water column are being evaluated along with the phytoplankton response to the various levels of these plant nutrients. Sediment samples are also taken semi-

annually for nutrient analysis. Hydrographic data were collected on each survey cruise to describe physical characteristics of the systems. Isohaline zones (areas of the same salinity) within and between these estuaries were compared.

Study of benthic animals off the Eastern Shore

A study was initiated and completed to determine the composition of bottom fauna in the offshore area between Wachapreague inlet and Assateague Island. Six transects were established from nearshore to forty miles offshore. Sixty-five bottom grabs were taken for analysis. Benthic organisms in the samples were identified and counted.

Heavy metal surveillance

A heavy metal monitoring program in cooperation with the State Water Control Board was continued.

Oysters were used as test animals since they were efficient in concentrating even low levels of metal ions from the water. The ten stations used in the pesticide study (see below) were utilized in this program. The samples were collected, homogenized, lyophilized and wet digested by VIMS personnel and then forwarded to the Water Control Board for analysis by atomic absorption.

The data indicated that the heavy metal content of oysters was within the normal limits in all areas except at Deep Water Shoal in the James River and Hospital Point in the Elizabeth River. The high levels found in these sites indicated that additional investigations should be made.

Pesticides in Virginia oysters

Oysters were regularly collected from two stations each in the James, York and Rappahannock rivers and one station each in the Elizabeth, Lynnhaven, Machipongo and Cherrystone Inlet systems to test them for the possible uptake of pesticides which might have been present in the surrounding waters. The samples were processed for analysis for chlorinated hydrocarbons. No values found up through June 1968 are believed to have been high enough to be of biological or public health significance.

Stinging nettle research

The stinging nettle *Chrysaora quinquecirrha* reduces the utility of marine waters for recreation and adversely affects the economy.

A program initiated in April 1968 was designed to study the ecology of this pest. Knowledge gained from this study will be applied to devising possible control measures. The present program entails:

1. A study of the seasonal rates of attachment of jellyfish polyps to shells held in wire bags in the James, York and Rappahannock rivers and stations in Chesapeake Bay.
2. A study of the number of polyps which set on natural and artificial substrates to determine their winter distribution and survival.

3. A study to estimate the abundance of adult jellyfish in various regions.

No polyps were detected on any of the experimental shell substrate at any station up to June 30, 1968.

MICROBIOLOGY-PATHOLOGY-PARASITOLOGY STUDIES

Algal culture laboratory

Algae were cultured to provide food for experimental organisms. In particular, they have supported the breeding program for MSX-resistant oysters and the program for culturing bivalve mollusks through their larval development. Five species of algae were grown in mass cultures: *Monochrysis lutheri, Isochrysis galbana, Cyclotella nana, Dunaliella tertialecta,* and *Phaeodactylum tricornutum.*

Withdrawals from algal cultures from July 1, 1967, through June 30, 1968, were:

Monochrysis lutheri	3697 liters
Isochrysis galbana	1046 liters
Cyclotella nana	250 liters
Dunaliella tertialecta	206 liters
Phaeodactylum tricornutum	1107 liters
Total	6306 liters

Larval culture laboratory

In the continuing effort to develop MSX-resistant oysters, eleven different crosses produced successful broods.

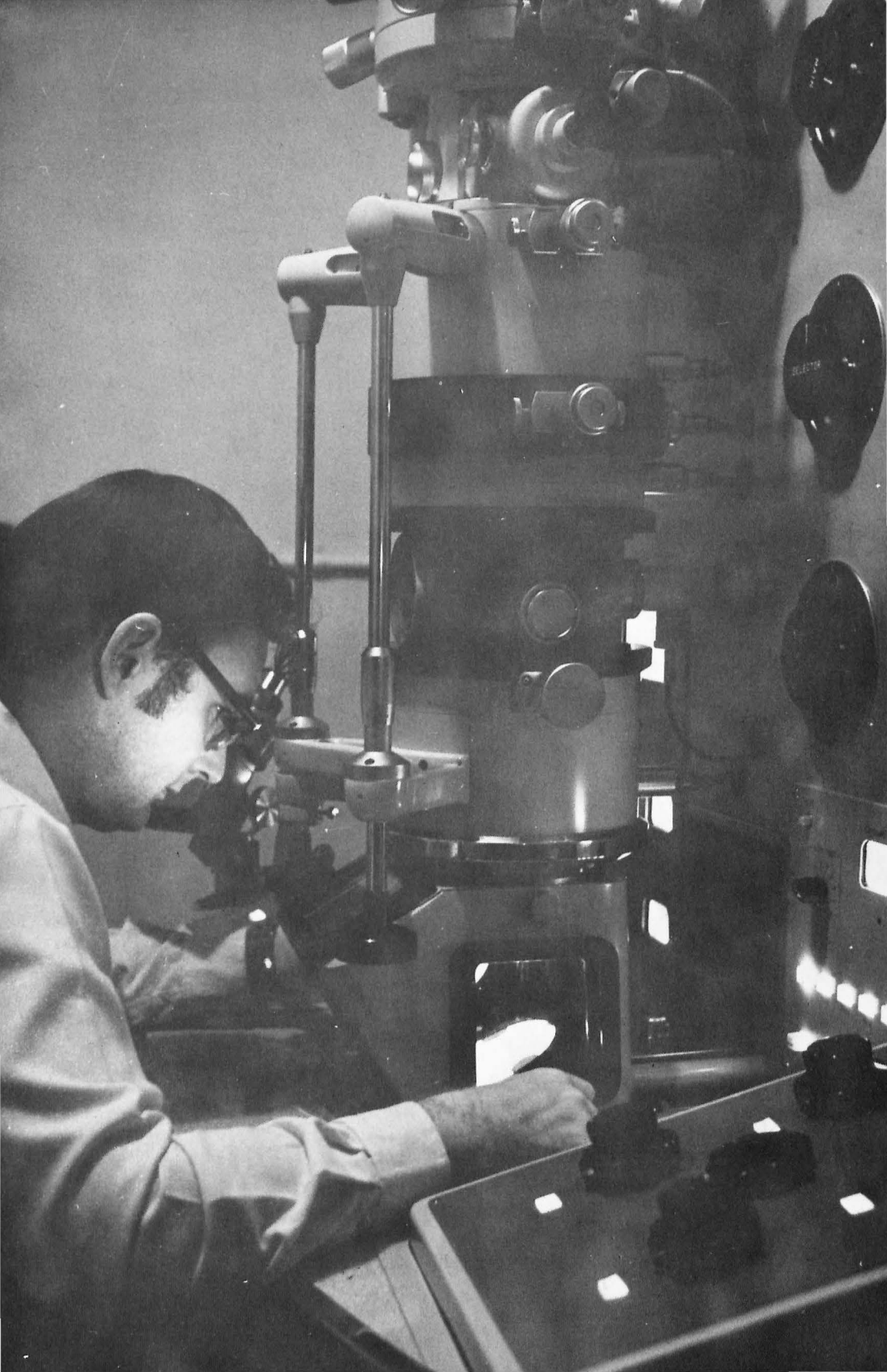
Initial steps have been taken to develop free spat, independent of cumbersome cultch.

Many Virginia bivalves have been bred and carried through their larval development in the laboratory. During the past year *Montacuta percompressa, Montacuta floridana, Amygdalum papyria* and *Brachidontes recurvus* were successfully spawned in the laboratory for the first time and raised through the initial larval stages. Improved methods for rearing and holding bivalve larvae in the laboratory are being developed. Behavior of nine species of bivalve larvae subjected to a range of salnities and temperatures was recorded.

Fine structure of marine organisms

Cellular biological studies at VIMS have been focused primarily on the fine structure of marine protists which cause diseases of commercially significant marine invertebrates as well as the fine structure of the complex of saprophytic protists which are closely related to disease organisms. The general fine structure of the following oyster pathogens, as found in oyster tissues, was examined and described:

VIMS microbiologists use an electron microscope in studies of intricate cell structure of disease organisms that infest important marine species.



1) *Minchinia nelsoni* or MSX
2) *Minchinia costalis* or SSO
3) *Labyrinthomyxa marina* or *Dermocystidium marinum*

Attempts to culture *L. marina* and *M. nelsoni* are now in progress. The ultrastructure of zoosporulation in *Labyrinthula* sp., a saprophyte closely related to *L. marina,* was also described and studies of motility, feeding, and centriole biogenesis were initiated.

In collaboration with Mrs. Virginia Proud of the College of William and Mary, attempts were made to isolate virus-like particles from the cytoplasm of *M. nelsoni* by differential centrifugation. The goals were not attained; however, further attempts to isolate the particles will be made.

Investigations were initiated to study the fine structure of the haplosporidian *Urosporidium* sp. a disease organism which affects the musculature of blue crabs.

The ultrastructure of tentacle muscle contraction in the jellyfish, *Chrysaora quinquecirrha,* is being investigated in collaboration with Drs. Robert and Sybil Ramsey of the Medical College of Virginia.

Parasitology

The work on parasites was part of a long-term endeavor aimed at increasing knowledge of the morphology, host-specificity, zoogeography, and phylogeny of monogenetic trematodes. During this report period, research was directed toward a study of the morphology of Monogenea from southern Pacific Ocean fishes.

These studies being undertaken by VIMS scientists are essential to world-wide analyses of host specificity and zoogeography of these interesting parasites. Data concerning parasites from the Pacific Ocean and Antarctic areas are being added to the systematic and ecological data from other localities of the world ocean already catalogued and stored in the VIMS Keysort "memory bank." Information collected and stored is pertinent to gaining insight into the operation of natural host-specificity.

Studies include:

1. Descriptive work of collections made in Antarctica (McMurdo Sound and Wilkes Station), New Zealand and Australia.
2. Collection of parasites in Antarctica 1967-68 by James K. Lowry and E. Lynn Suydam, from both vertebrate and invertebrate hosts.
3. Studies of larval stages of monogenetic trematodes of some Chesapeake Bay fishes. This work contributes to the study of phylogeny and adult morphology of these parasites.
4. The study of the host specificity of ectoparasitic trematodes.

The projects of the Parasitology Section were almost entirely supported by grants from the National Science Foundation during the period covered by this report.

Oceanographers at VIMS have taken numerous core samples of James River bottom sediments for laboratory analysis to determine characteristics that make certain bottoms favorable for oyster production.

PHYSICAL, CHEMICAL AND GEOLOGICAL OCEANOGRAPHY

Hydraulic and mathematical model research

During May and June, 1968, physical oceanographers conducted a series of experiments in the James River model at Vicksburg, to determine the nature of its approach to steady state and the limits within which the characteristics of the system remain constant once steady state is reached. These tests were conducted to determine the usefulness of the hydraulic model as a scientific tool.

Computer programs for the presentation of data by a function of two variables have been developed. The programs yield isopleths of various parameters based on polynomials of Fourier series. The immediate use for this technique is the reduction of data from the Shelf Hydrographic Survey, but a great variety of uses is possible.

Preliminary research was done on the feasibility of developing sensors for measuring velocity, salinity, and temperature in a hydraulic model. An automatic recording system could receive information from many sensors, and thus gather a quantity of data which would be impossible to collect by manual means.

A computer program was developed for bringing the method of power spectral analysis to bear on the problems of the relation between river dis-

charge and salinity and the relation between fluctuations of salinity at two points in the same system. This technique makes it possible to determine the relative importance of various influences on the salinity at a given point, and the time delay between a change in the influencing factor and the response of the system. Hence, it is a highly useful tool for developing an empirical picture of the behavior of an estuary or river.

In cooperation with NASA-Wallops, work was started on an *in situ* sensor to measure water temperature, salinity, pressure and current velocity. Such an instrument would speed up considerably the process of gathering the data for the Shelf Hydrographic Survey, for example. It would pay for itself by reducing crew requirements and cruise durations.

At the suggestion of VIMS scientists in the Physical, Chemical and Geological Oceanography Department, NASA-Wallops made arrangements to outfit the U.S.N.S. *Range Recoverer* with a chemistry laboratory, hydraulic winch and oceanographic work platform. These devices are mainly for use in offshore work.

Fatty acids concentrations in marine waters

Chemical oceanographers have initiated a project to determine the concentrations of fatty acids in coastal and estuarine waters. Fatty acids tend to spread on the water surface and affect the momentum transfer and oxygen transfer between the ocean and atmosphere. It is also thought that a careful analysis of the fatty acids at a given point will reveal the kinds of fish and plankton to be found nearby.

Surveys of Atlantic coastal waters and Chesapeake Bay

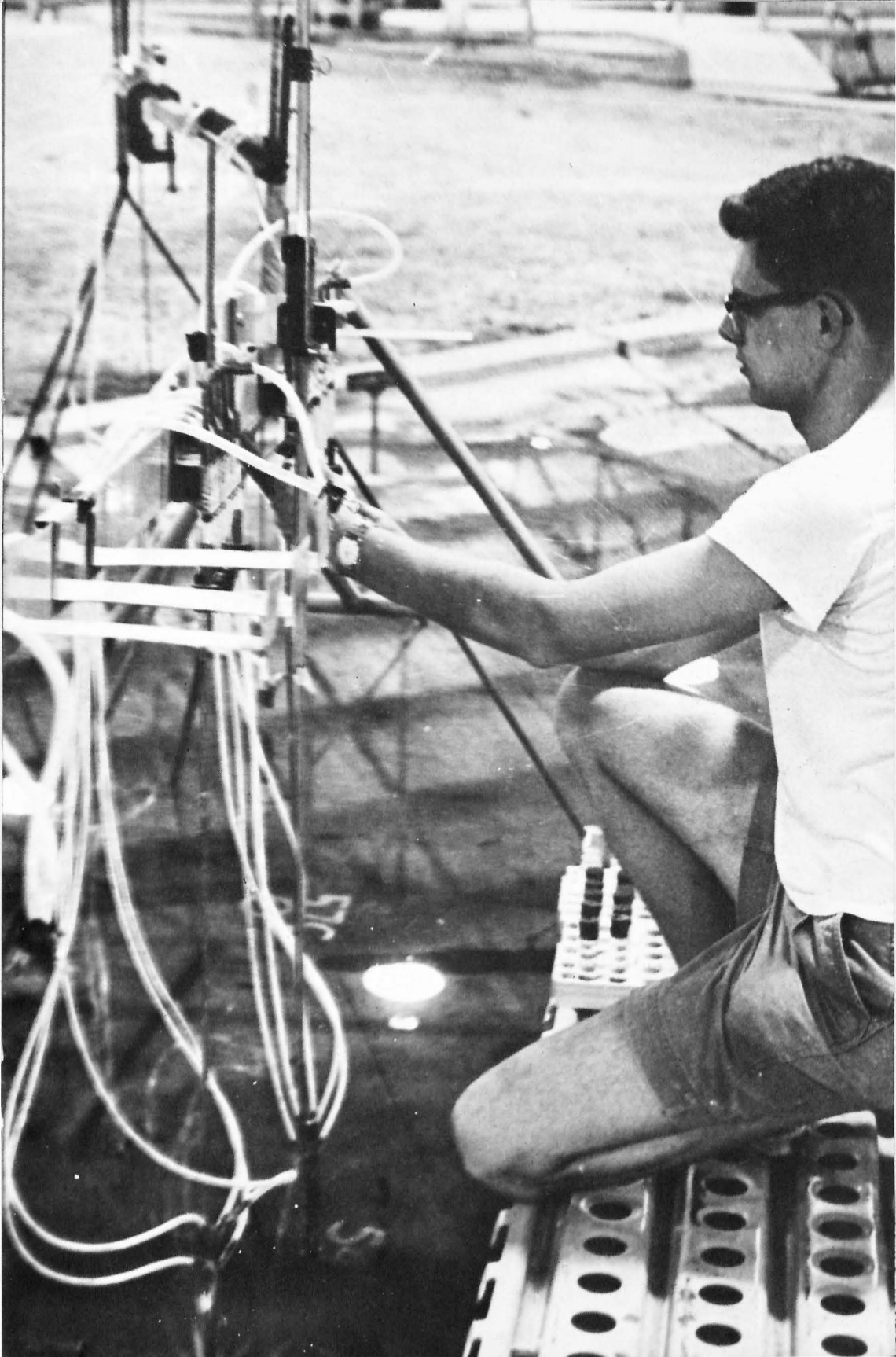
VIMS has continued to work on a periodic survey of the temperature and salinity structure of the oceanic waters over the continental shelf just outside the mouth of the Chesapeake Bay. From the data gathered, a picture is emerging of the motion of water masses which shows the influence of seasonal fluctuations of the meteorological condition on continental shelf water.

For some of the cruises, the Wallops Island installation of NASA has made available to VIMS scientists the U.S.N.S. *Range Recoverer* on a not-to-interfere basis. Use of this vessel makes possible more rapid and efficient collection of data.

In cooperation with other members of the Chesapeake Research Council, VIMS has taken part in a survey of Chesapeake Bay and tributaries. Data collected include temperature, salinity and oxygen distribution throughout the water column.

In June 1968, VIMS and NASA-Wallops cooperated in a preliminary aerial survey. NASA aircraft, equipped with an infrared camera and scanner,

Physical oceanographers used the James River Hydraulic Model to study the feasibility of developing sensors for measuring velocity, salinity and temperature in a hydraulic model.



flew tracts along the Eastern Shore and from Plumtree Island in the Bay across the Chesapeake light tower to the edge of the continental shelf, collecting data on surface temperature and infrared spectral characteristics of surface water.

Ocean currents off Virginia Beach

A project, initiated in December 1967 and which will continue through the fiscal year 1969 under funding from the U.S. Army, Corps of Engineers, will describe the bottom currents in the Atlantic Ocean off Virginia Beach, Virginia. Previous studies (Harrison, Brehmer and Stone, 1964) indicated the presence of a nearshore gyral off Rudee Inlet. This study is designed to establish the stability of the circulation pattern and to determine the factors responsible for shifts in the net non-tidal drift.

In December 1967 and January 1968, the net-set of the nearshore currents was to the south. After about a two-week period of transition, the net-sets shifted to the north and continued in this direction through the summer. These data augment those of Norcross and Stanley *in* Harrison, Norcross, Pore and Stanley (1967).

James River bottom sediments

As part of the institute-wide study of the James River, bottom sediments were cored throughout the estuary and analyzed in the laboratory to determine characteristics that make certain bottoms a favorable substrate for oyster production. On examination, these sediments were found to be contaminated by small proportions of coal, cinder and fly ash which accumulate along the south channel shoulder. Effects of man-made structures on bottom deposits are mainly limited to changes in the local patterns of sedimentation. Filling of this estuary is relatively slow since sediment discharge by dams is properly controlled, and agriculture is conducted in a manner designed to reduce erosion. The estuarine circulation is such that it flushes sediment seaward through the estuary.

Sediment transport

Estuarine waters are typically charged with suspended sediment swept off the bottom by the alternating ebb and flow of the tide. An attempt was made to measure this phenomena in the Rappahannock River estuary as part of a cooperative effort with ESSA.* Data were analyzed to discover what net or residual transport takes place to trap sediment in some areas or to flush it out to sea. Although sediment accumulates locally in the middle estuary and near the head, most of the river-borne load was found to escape seaward over the south bank. It seems likely that engineers can take advantage of this natural self-flushing feature in arranging for dispersal of spoil and wastes in future projects.

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*Environmental Science Services Administration

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*Environmental Science Services Administration

Characteristics of the bottom sediments and benthic fauna of the inner continental shelf

The inner continental shelf extending 40 miles off the Eastern Shore between Chesapeake Bay mouth and Assateague has been sampled on a 2 to 4 mile grid at various times from 1962 to 1967. Grab samples processed in the laboratory for grain-size, coarse-fraction mineralogy, foraminiferal composition, carbonate and organic carbon content, show distributions that trace the recent geological history of the area. They also reveal sources of sediment and deposits of potential economic value, including "showings" of gravel, phosphate, and heavy minerals. Distributions of organic content, grain size and benthic invertebrates will be examined to determine how they may affect the distributions of benthic fishes. This is a preliminary investigation aimed at gaining a broad picture of the shelf floor to identify resources that require future study.

Multiple bars of Chesapeake Bay

The distribution of multiple sand bars bordering Chesapeake Bay was studied from aerial photography and from field observations to determine their development and stability. Using tracers, depth profiles, current and wave sensors at a field location, it was concluded that the bars are relatively stable and move only during storms when breakers form a great distance from shore.

Hampton Roads circulation

Measurements of currents and salinity in Hampton Roads obtained from varied surveys in the harbor over the years and in the James River hydraulic model, were studied to establish their range with variations in river inflow and man-made harbor modifications. Potential avenues of oyster larvae transport have been identified and sediment traps delineated. Information obtained

The R/V LANGLEY, a converted ferry, is in constant use by ichthyologists and other scientists as an excellent floating laboratory for estuarine research.

from these measurements of circulation and sedimentation will permit future evaluation of pollution in this area and will enable engineers to plan port construction in keeping with natural conditions.

PHYSIOLOGICAL STUDIES

Amino acids

A study of amino acids in the York River and a study of amino acids released by marine zooplankton, both started in 1965, have been completed.

The extraordinarily high concentration of amino acids detected in York River in late summer 1965 have not been observed since. Two and one-half years of weekly observations have been accumulated and routine sampling has been discontinued. No significant seasonal variations of total dissolved free amino acids have been correlated with other natural processes in the estuary.

Dissolved organic matter in York River estuary included 38 micrograms of free amino acids per liter. The highest concentrations were of glycine, serine, and ornithine. Of the 14 amino acids studied for uptake by planktonic bacteria, glycine, methionine and serine had the greatest flux rates. The total amino acid flux represented from 1 to 10 per cent of the daily photosynethic carbon fixation.

Rates of release of dissolved free amino acids by marine net zooplankton are a positive function of water temperature and can be estimated by the equation R=T-6.0, where R=release rate in mg x-amino N g^{-1}, T=temperature (°C), and 6.0 is a constant. Most of the common protein amino acids are present in release products. Glycine, taurine, and alanine usually predominate. It is estimated that in an "average" water column net zooplankton release in about one month an amount of total dissolved amino acids equal to the amount in solution at any given time.

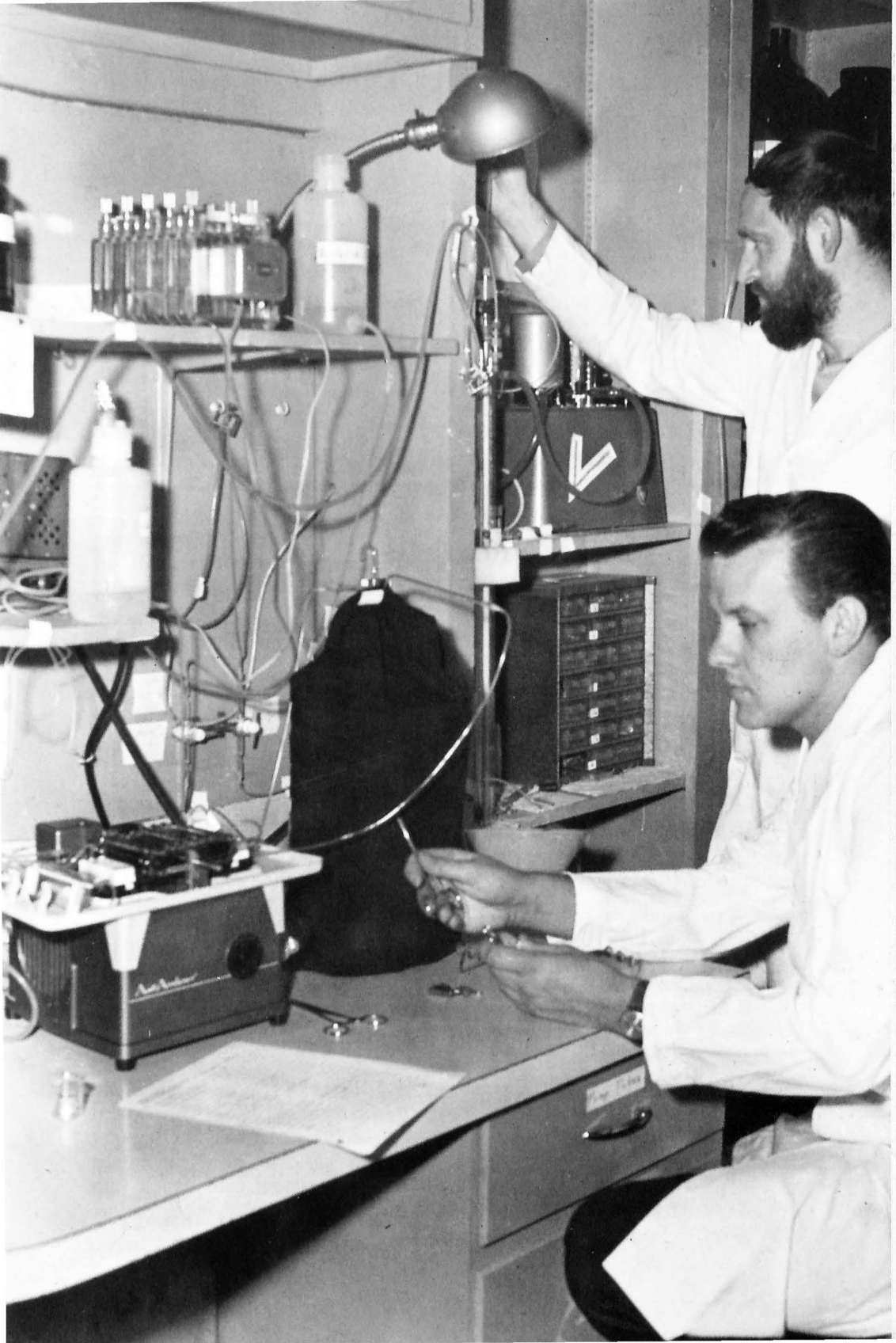
Continuing physiological research

A number of projects, begun during the years 1965-67, were continued in 1967-68. Scientists are studying the relationship between environmental parameters and internal dissolved free amino acids (DFAA). Measurements of the flux of DFAA in marine ecosystems are being recorded and amounts of DFAA in samples of ocean water from the western Atlantic are being measured.

Studies are being conducted to learn how physiological and ecological factors influence prey selection, and how diseases and pests affect physiological and biochemical responses of organisms to various stimuli.

Studies of physiological and ecological aspects of larval transport are in progress.

A semi-automatic amino acid analyzer is used by physiologists in studying the relationships between dissolved amino acids in sea water and the organisms living in these waters.



A permanent VIMS field laboratory located at Wachapreague on Eastern Shore is used for studies of oysters, clams, scallops, marsh lagoons, and erosion of barrier islands.

WACHAPREAGUE LABORATORY

Monitoring of trays of oysters strategically located in waters on both sides of the Eastern Shore peninsula is being continued to record the range and intensity of various oyster diseases. Shellbags monitored regularly are use to assess the intensity and time of spatfall.

Practical methods for culturing clams and scallops are being developed on Eastern Shore. One of the problems of successful culture practices is that of supplying acceptable food. An artificial food has been tested with fair results.

Post-larval clams are subject to heavy predation in natural waters. Methods are being tested for protecting small clams from predators.

Experiments of a preliminary nature have been conducted to learn the larval behavior of some of the commercial mollusks. Studies of the salinity tolerance of pelecypods have been completed for the common species; some of the less common species were tested during the year.

A benthic jet sampler, developed at VIMS, Wachapreague, has been used extensively and found to be excellent for collecting bottom organisms.

SERVICES AND FACILITIES SUPPORTING RESEARCH

Data processing and statistical services

An IBM 1130 computer, replacing the IBM 1978 remote terminal and IBM 407 accounting machine, was installed in September 1967. This is used in association with the IBM 360 computer of the Cooperative Computer Center, located at The College of William and Mary. The 1130 has proven to be a highly reliable and versatile machine. A printing card punch with interpreter and full character set and verifier were installed in November 1967.

The point is being approached where daily available time on the 1130 computer will not be sufficient to meet the demand. A significant increase in data volume will overload the system. A proposed system expansion has been developed for approval by Mr. Gordon W. Mills, Director, Division of Automated Data Processing, Governor's Office, Commonwealth of Virginia.

Personnel in the Data Processing and Statistical Services Department have made great progress in developing methods for handling accounting data. Purchase orders and payroll are now processed by the computer and in the near future the department will be able to handle virtually all accounting requirements.

Library

Library accessions increased during the year with funds supplied by grants from the Old Dominion Foundation, from the Virginia Sportfisherman's Associate and from funds available through federal grants.

There were 644 new books added to the collection, together with 66 new serial titles, 7 microfiche sets, 1 set of microcards, and 4 long microfilms. In addition, 264 back volumes of periodicals were purchased. A total of 1,128 books was accessioned, including 437 bound volumes of periodicals.

The list of serial titles in the library was revised during the summer of 1967. An annotated copy of this list was prepared for inclusion in the union list of scientific periodicals being assembled at the University of Virginia, College of Engineering.

Reprints of 34 contributions published during 1967-68 were assembled and distributed to the exchange list. One Data Report was published during the fiscal year and distributed. In addition to regular exchange lists, 2118 separate reprints, 16 Data Reports, 26 Translations and 94 Special Scientific Reports were supplied in answer to individual requests.

Newly acquired Facilities and Equipment

During this report period VIMS has leased 14 acres on which are located two buildings and mooring facilities for medium-size boats with access to the York River. Small boat activities are being conducted from this facility. Future plans call for the acquisition of this property and the installation of running saltwater rearing ponds for appropriate research activities.

Ground was broken for the construction of a pollution-ecology building on August 24, 1967. Most of the framework was in place by June 30, 1968. This building will add 19,000 square feet of work space to the Gloucester Point facilities.

A de Fonbrune microforge and micromanipulator was provided for improved research on algae.

The VIMS communication center was improved by adding telephones in many offices and a new switchboard. An additional incoming line was connected.

Improved data processing equipment was installed during the report period. (See Data processing and statistical services above).

Courses leading to the M.A. and Ph.D. degrees are taught on the VIMS campus through affiliation with the College of William and Mary and the University of Virginia.

ACADEMIC AND TRAINING PROGRAMS

Graduate programs

The Virginia Institute of Marine Science, through association with the College of William and Mary and the University of Virginia, provides an academic program leading to the degree of Master of Arts and Doctor of Philosophy in Marine Science. Majors in Biological Oceanography, General Oceanography, and Fisheries Biology are available.

During the school year 1967-68 sixty students were enrolled. Of these, 11 received master's degrees and one received a doctorate degree.

Summer programs

During the summer of 1967 the Institute operated three programs supported by the National Science Foundation funds:

Research Participation for College Teachers (financed through NSF Grant GY 2385). Four college teachers spent twelve weeks at VIMS.

Undergraduate Research Participation for College Students (financed through NSF Grant GY 2829). Ten college students spent ten weeks at VIMS in research training.

Cooperative College-School Science Program (financed through NSF Grant GW-1771). Fifteen teachers were admitted to the program, which was conducted at Norview High School, Norfolk, Virginia, for eight weeks during the summer of 1967. This was a joint undertaking between VIMS and the Norfolk School authorities to improve science teaching. Dr. John I. McClurkin, Department of Biology, Randolph-Macon College, Ashland, Virginia, was the instructor.

PUBLIC INFORMATION AND EDUCATION

During the 1967-68 report period, 3255 visitors registered at the Institute. These included groups of students from 13 colleges and 65 elementary and high schools who attended lectures or collected material from marine waters.

Several research scientists and information officers presented programs to civic clubs throughout the Tidewater area.

Over 19,750 pieces of literature along with 400 letters were mailed to persons requesting information. Seventy inquiries for special information were handled by telephone.

Sixty-three newspapers and 257 persons received thirty-nine press releases prepared by the Information and Education Department.

An exhibit was set up for three days at the Waltonian Sportsman Show in Norfolk and at the Virginia Academy of Science meeting in Richmond.

VIMS is represented on the Resource-Used Education Council of Virginia and assisted the Council in presenting a conservation short course at Virginia State College, Madison College, and the College of William and Mary.

Staff members served as judges at science fairs in several tidewater schools this past year.

Five staff members prepared six television lessons for broadcast over the Hampton Roads Educational Television Station WHRO:

Dr. Morris L. Brehmer:	Pollution of Marine Waters
Mr. Robert S. Bailey:	Uses of Saltwater Resources In Tidewater Virginia
	Economic Importance of the Sea
Dr. W. G. MacIntyre:	Apparatus Used in Astronomy
Dr. Maynard Nichols:	Chesapeake Bay
Mr. E. P. Ruzecki:	The Greenhouse Effect

These programs were preserved on video tape and will reach several thousand school children over a period of years.

The staff of the Information and Education Department was increased by three during the fall of 1967 to enable it to perform special services under the State Technical Services program. The purpose of this program is to disseminate information useful to people engaged in business and industry utilizing marine resources.

Thirty-six hundred pamphlets were distributed to commercial and sport fishermen to provide general information about summer flounder, striped bass, American shad, Atlantic menhaden and soft shell clams.

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George Snow	Captain
Randy D. Hickman	Mate
William H. Kreite*	Mate
John E. Tillage	Engineer

*Joined staff during this report period.


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